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Description

Arrangement and method for transmitting data

Data terminals such as routers or switches have an interface for local applications such as local area networks, which is referred to in IEEE Draft Recommendation P802.3z as an 1000BASE-X interface. This interface, which is referred to as a Gigabit Ethernet interface, results, however, in the disadvantage that it can be used to supply only appliances within a limited circular range of, for example, 100 meters.

Assuming that the Gigabit Ethernet signal has a nominal bit rate of 1 Gbits/s, the Gigabit Ethernet signal is subjected to 8B/10B coding in accordance with IEEE Draft P802.3z, resulting in the bit rate being increased from 1 Gbits/s to 1.25 Gbits/s. This coding results in as many signal transitions as possible and in a signal which has no DC level, and this in turn allows simpler regeneration of the signal and clock recovery at the receiving end.

Transmission networks, for example, are used for transporting Ethernet signals in the Gigabit band to other networks such as MAN and WAN networks. Normally, within Europe, these transmission networks use transmission systems which operate on the basis of the synchronous digital hierarchy SDH, in accordance with ITU Recommendation G.707. In the USA, these systems operate in accordance with the SONET Standard, which is likewise defined in G.707.

The invention is based on the object of providing a further arrangement and associated method for transmitting Ethernet signals.

The object is achieved by the features of patent claims 1, 2, 3 or 7, 8.

In addition to the advantage that SDH transmission network, which is widely available, can be used for transmitting Gigabit Ethernet signals, the invention provides the further advantage that STM frames are used for data transportation, and the capacity of an STM-N signal is used optimally.

The invention provides the advantage that only eight VC-4 containers in an STM-N signal are used for transmitting a Gigabit Ethernet signal, so that, for example, up to two Gigabit Ethernet signals can be transmitted in one STM-16 signal, and up to eight Gigabit Ethernet signals can be transmitted in one STM-64 signal.

Further special features are specified in the dependent claims.

The arrangement and the associated method are described in the following more detailed explanation of exemplary embodiments and with reference to drawings, in which:

Figure 1 shows a transmission path for a Gigabit Ethernet signal,

Figure 2 shows an STM-N frame with one line of a signal, and

Figure 3 shows a concatenation of signals.

The following text is based on a Gigabit Ethernet signal at a bit rate of 1.25 Gbits/s. According to Recommendation G.707, a bit rate of 2.488320 Gbits/s is defined for STM-16 signals, and a bit rate of 9.953280 Gbits/s is defined for STM-64 signals.

The following description indicates a way in which the transmission capacity of an STM-N signal, for example

an STM-16 signal, is produced for transporting at least two Gigabit Ethernet signals.

In the method according to the invention, the bit rate of a Gigabit Ethernet signal is reduced in the form described in the following text, in order to make it possible to achieve the basic data, as specified in the recommendation, for STM-N signals.

As is illustrated in figure 1, 1.25 Gbits/s Ethernet signal E1 is supplied, before transmission via the transmission network S, to a 10B/8B decoder DEC, a first multiplexer M1, a collator M and a second multiplexer M2. The first multiplexer M1, which follows the 10B/8B decoder DEC, combines the 8-bit data words and the monitoring information to form a 9-bit signal 9B, with one bit in each case being added to the data words of the output of the decoder DEC depending on whether this is a data word or a monitoring information word.

A data word is marked, for example, by a bit whose logical value is only "1", and a monitoring information word is marked by a bit whose logical value is only "0". The combination of the output signal from the decoder DEC by the mutliplexer M1 results in a signal with 8B/9B coding. The bit rate of 1.25 Gbits/s, which is applied to the input of the decoder DEC, is converted in the first multiplexer M1 to a signal at a data rate of 1.125 Gbits/s.

One Gigabit Ethernet signal supplies a total of 15625 bits during one period of an STM frame with an 8 kHz frame frequency and 9 lines per frame (see figure 2). The total number of bits per frame line in the STM-N signal is obtained from the following calculation:

$$1.125 * 10^9 : 8\ 000 : 9 = 15625 \text{ bits.}$$

The output signal from the first multiplexer M1 can be passed on via a scrambler SCR or directly to the collator M which is referred to in the following text as a mapper and, in the receiving device following the transmission path S, as a demapper DEM. The output signal from the mapper M, a first signal sequence, formed from contiguously concatenated signals VC-4-8c, or from virtually concatenated signals VC-4-8v, has further first signal sequences added to it in a second multiplexer M2, with the addition of SDH-specific overhead information OH to form an STM-N signal (N = 16, 64, 256,...).

In the receiving direction forming a transmission path S, the overhead information OH is first of all removed from the STM-N signal in a first demultiplexer DM2, and individual first signal sequences VC-4 are formed from the signals. The 1.125 Gbits/s signal is recovered in the demapper DEM from the contiguously or virtually concatenated signal VC-4-8c/VC-4-8v, in an analogous way to that in the transmission direction. In the case of virtual concatenation of VC-4 signals, different delay times of the concatenated VC-4 signals must be compensated for in suitable buffer memories, as is described in more detail in European Patent Specification EP 0429888 B1. If the 1.125 Gbits/s signal has been scrambled at the transmission end, this must be reversed in a descrambler DES.

The demapper DEM or the descrambler DES is followed by a second demultiplexer DED1, which emits an 8-bit signal 8B as well as information as to whether this is data or monitoring information. A subsequent 8B/10B encoder ENC uses this to produce an Ethernet signal at a data rate of 1.25 Gbits/s, corresponding to the method defined in IEEE Draft P802.3z.

For transmission within an STM-N signal, it is

possible, instead of 8B/10B coding, to use a scrambler which likewise ensures sufficiently frequent signal transitions.

The 8B/10B coding is described in Tables 36-1a to 1e of IEEE Draft Recommendation P802.3z, and monitoring information is described in Table 36-2.

The following text explains how one line of an STM frame is subdivided:
1736.1111 x 9 bit combinations can be formed from the bit sequence formed above.

Since one line of an STM frame has a transmission capacity of 1848 x 9 bits, the subdivision of user information, stuffing information, stuffing monitoring information and blank information can be chosen, by way of example, as shown in the following table:

1735	x	9 bits	User information
2	x	9 bits	Stuffing information
6	x	9 bits	Stuffing monitoring information
105	x	9 bits	Blank information (fix stuff)
1848	x	9 bits	Total

The maximum permissible frequency error of the Gigabit Ethernet signal may be ±100 ppm (parts per million) in accordance with IEEE Draft P802.3z. With the proposal to provide two stuffing information items of 9 bits per line, 1735 to 1737 x 9 bits of user information can be transmitted per line. The Gigabit Ethernet signal must therefore lie in the following frequency band:

$$1735 \times 9 \times 9 \times 8000 = 1.124\ 280 \text{ Gbits/s to}$$
$$1735 \times 9 \times 9 \times 8000 = 1.125\ 576 \text{ Gbits/s.}$$

This corresponds to a maximum permissible frequency error in the Gigabit Ethernet signal of +512 ppm or -640 ppm, thus reliably satisfying the above requirement of ±100 ppm.

Depending on the state of the two stuffing monitoring

information items C1 and C2, 1735 or 1737 x 9 bits of user information can be transmitted

per line. If the three stuffing monitoring information items C1 each, for example, have the combination 000000000, then this indicates that the 9-bit word S1 in the line contains user information, while, if the combination is 111111111, the 9-bit word S1 contains stuffing bits, that is to say does not contain any user information. The same applies to the stuffing monitoring information items C2 and the stuffing information S2. In order to be protected against individual and bundling errors in the stuffing monitoring information, a majority decision is carried out in one advantageous refinement.

Figure 2 shows how a bit sequence in one line of the C-4-8c signal is broken down in an STM frame. One line of the user data signal in the STM frame has a length of 2080 bytes and is broken down, as shown in figure 3, into four subgroups. The fourth subgroup is terminated by blank information FS.

Figure 3 shows a detailed breakdown of a line formed from 2080 bytes. This line is subdivided into four subgroups, with the first three subgroups being identical and each starting with a first 9-bit stuffing monitoring information item C1. This is followed in each of these three subgroups by 144 bits of user data, which are transmitted in 16 x 9 bit groups D16. The user data is in each case followed by a 9-bit long blank information item FS (fix stuff). The combination formed from the user data 16D and the blank information FS is repeated 26 times per subgroup. This is in each case followed by a further 16D user data groups, with a second stuffing monitoring information item C2. The first three subgroups each end with the transmission of two user data groups D, each having 18 bits.

The fourth subgroup starts with a stuffing information item S1. This is in each case followed, as in the first

three subgroups, 26 times by the combination 16D of user data information with a 9-bit long blank information item FS. A further 16D user data groups are followed by

the stuffing information item S2. A user data group D with 9 bits is followed by two sections of blank information FS, each having 9 bits.